Generation IV Supercritical Carbon Dioxide Corrosion Apparatus

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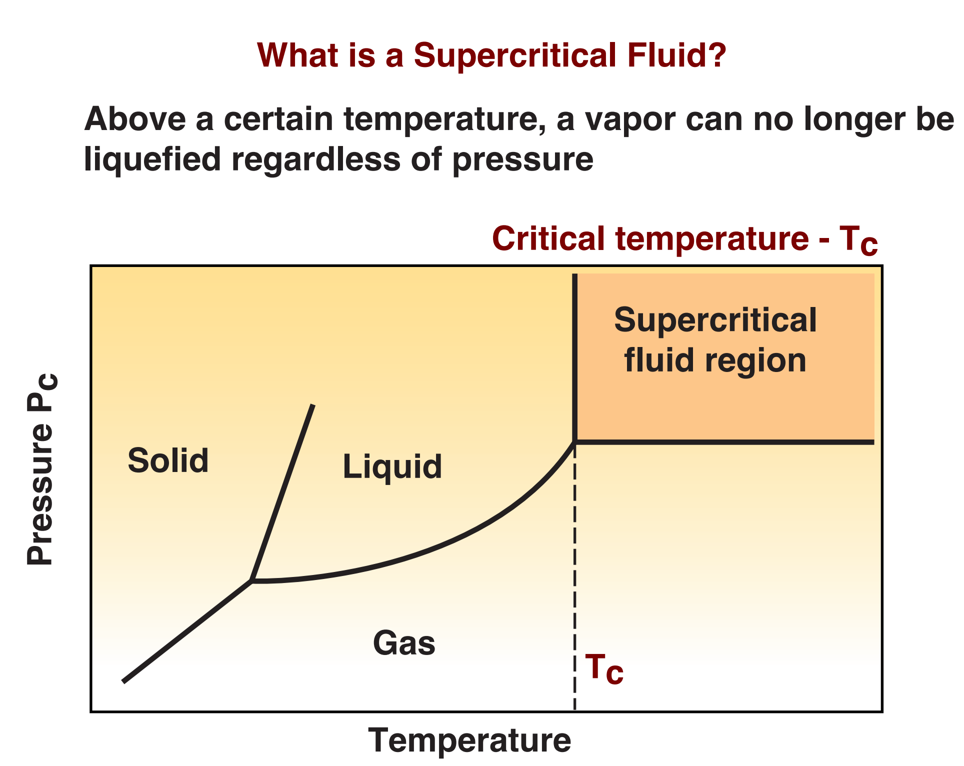
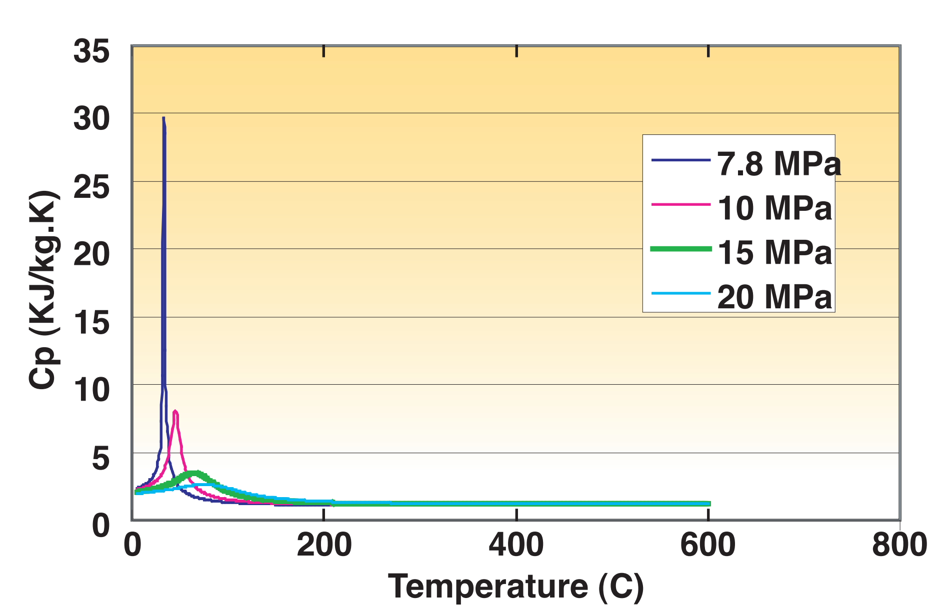
I. Introduction

The Idaho National Engineering and Environmental Laboratory has been conducting research in Gen IV reactor technology. One of the proposed types of Gen IV reactors is a gas-cooled fast reactor. This experiment explores CO_2 steady-state corrosion experiments performed at high temperatures and pressures to study quantify and structural material performance.

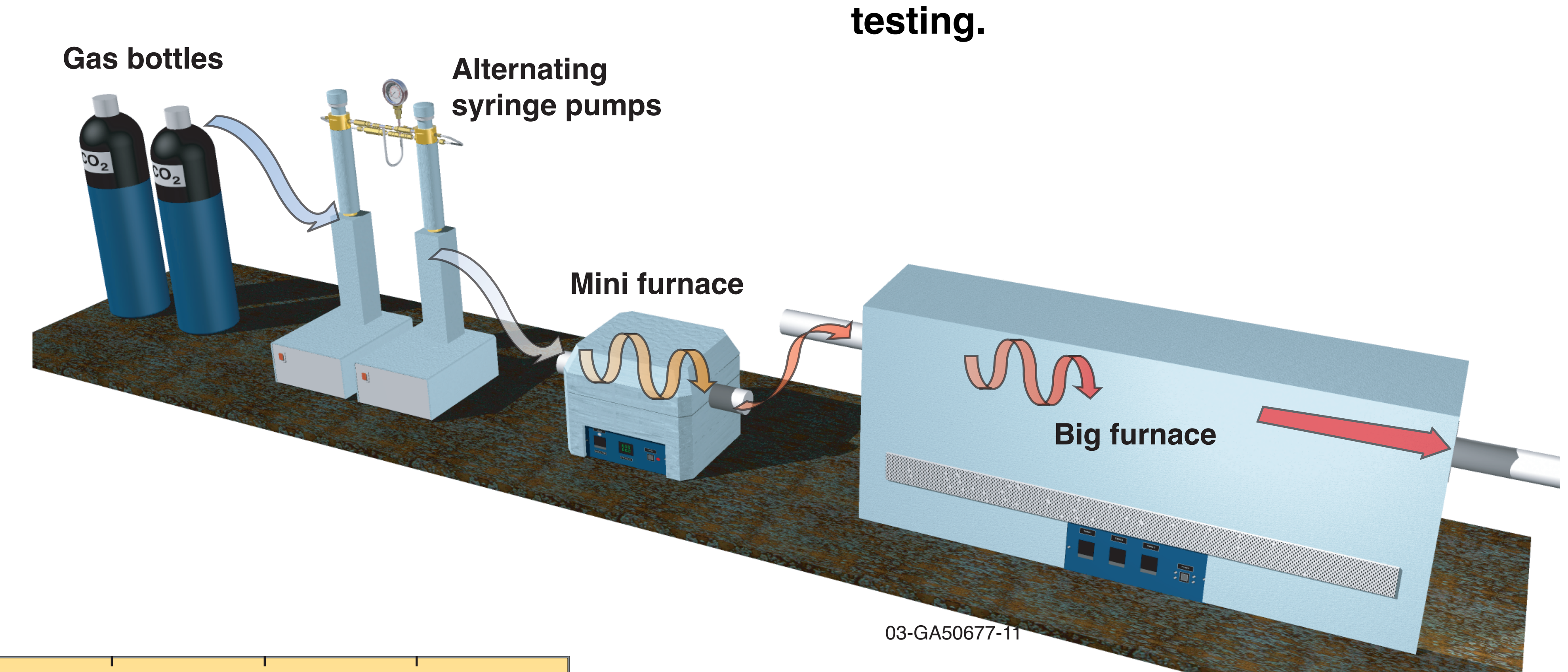
II. Supercritical CO_2



http://ull.chemistry.uakron.edu/chemsey/super



Supercritical carbon dioxide is a prime candidate for gas-cooled nuclear reactor coolant when compared to helium and superheated water. CO_2's higher molecular weight reduces leakage from the system. SC CO_2 also features a lower compressor work due to the high density when in the supercritical state, and can achieve high efficiencies estimated at 50% when operated at 650°C and 20 MPa. Another added benefit of SC CO_2 is that no phase changes will be present in the reactor system, allowing for greater efficiencies.

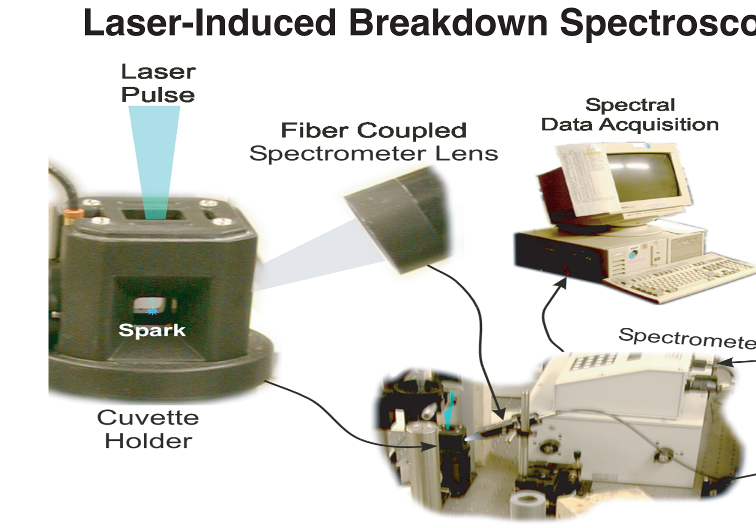


III. Testing Materials

Type of Tubing	Fe	Cr	Ni	Mo	Mn	Si	C	N	Cu	V	W
316	62	18	14	2.75	2	0.75	0.03	0.1	0.5		
304	70	19	10		2	0.75	0.03	0.1			
SAF 2507	Balance	25	7	4	1.2	0.8	0.03	0.3			
422	84	12	0.75	1	1	0.075	0.2			0.23	1
Titanium	0.046						0.0054	0.0049			
Carbon Steel	Balance				0.51	0.15	0.1				

Current industry standard stainless steels and other common tubing metals will be the focus of experimentation.These metals will be tested at 3000 psi and 600°C, and then analyzed for various corrosion layers and performance under destructive testing.

Laser-Induced Breakdown Spectroscopy



IV. Experimental Analysis

Two methods will be utilized to help determine the severity of corrosion and the different layers present on the metals. The test specimens will first be analyzed using a scanning electron microscope, allowing detailed photography of certain corrosion phenomena. Second, a cross section of the corroded tubing will be analyzed using laser spectroscopy. A pulse laser will generate a small region of plasma (approx. 1-2 microns in length), which will emit light then picked up by fiber optics and sent to a spectrometer. By comparing the concentrations of elements determined using the spectrometer, it will be possible to distinctly identify the composition of the various corrosion layers.